THE GENERALITY OF THE AUTOSHAPED RESPONSE

An abstract of a thesis by
Mark Premock
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Drake University
Advisor: William D. Klipec

The problem. To determine if autoshaping is restricted to responses which are biologically pre-organized, or if a response which is not overlearned or pre-organized, but is elicited by an appetitive stimulus (grain), can be autoshaped.

Procedure. The autoshaped responses of two debeaked pigeons which had developed modified eating responses were compared to responses made by three control subjects which contacted grain normally.

Findings. The control subjects exhibited normal keylight responding almost exclusively. The experimental pigeons contacted the key with a percentage of normal and modified responding similar to that directed to grain, though the modified responses were less extreme.

Conclusion. The results of this study demonstrate that a component of the modified eating response is directed to a keylight which is paired with grain availability.

Recommendations. Further experimentation in this area is necessary before all the variables which control the form of the autoshaped response can be determined.

THE GENERALITY OF THE AUTOSHAPED RESPONSE

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Mark Premock

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by

Mark Premock

Approved by Committee:

William D. Hyser
Chairman

W. Scott Wood

Frances A. Rogers

Earle L. Canfield
Dean of the School of Graduate Studies

434496

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CHAPTER I

INTRODUCTION

The Operant-Respondent Dichotomy

Prior to Skinner's (1938) operant-respondent dichotomy, the major learning paradigms were those of Pavlov (1899-1903) and Thorndike (1903-1930). Pavlov attempted to describe all behavior in terms of conditioned reflexes, whereas Thorndike explained it from the perspective of instrumental learning.

Skinner (1938) recognized that these two sets of learning principles dealt with two different conditioning procedures. In respondent conditioning, there was a stimulus-reinforcer contingency: The reinforcer (e.g. food) was presented only after the stimulus (e.g. tone) had occurred, independent of the occurrence of any response. In operant conditioning, there was a response-reinforcer contingency: The reinforcer (e.g. food) was presented only after the response (e.g. pecking key) had occurred. While prior stimuli were thought to control the operant response, their role was diminished because they were often difficult to identify. In addition, many learning theorists have traditionally taken the position that, while respondents were autonomic responses, operants were skeletal responses (Keller & Shoenfeld, 1950; Kimble, 1961; Konorski & Miller, 1937; Mowrer, 1947, 1950; Solomon & Wynne, 1954).

In recent years the operant-respondent distinction has fallen under heavy criticism (e.g. Staddon, 1973). One significant experiment in this area was that conducted by Brown and Jenkins (1968). The procedure used followed that typical of respondent conditioning. A keylight was presented and remained on for eight seconds prior to the presentation of food to pigeons in an experimental chamber. However, the pigeons were unrestrained. The intertrial interval varied, and food presentation was response-independent. Within 160 trials all 36 subjects made a key peck while the keylight was on. Control groups verified that the acquisition and maintenance of the pecking response was dependent upon light-food pairings, in that order. Brown and Jenkins labeled their procedure "autoshaping."

These results have been replicated using different stimuli (e.g. Ackil, 1972, with a tube; Moore, 1971, with a lamp) and different reinforcers. In a classic autoshaping experiment, Jenkins and Moore (1973) demonstrated the relation between the reinforcer and the form of the resulting conditioned response. They showed that when grain was used as a reinforcer, pigeons responded to the key with a grain-pecking movement. When water served as the reinforcer, the response resembled drinking-like movements. Thus, the response to each stimulus matched the consummatory response to the particular reinforcer that followed the stimulus. This same result has also been obtained in an operant situation (Wolin, 1968).

Peterson, Ackil, Frommer, and Hearst (1972) compared the conditioned responses made by two groups of rats to a retractable lever paired with either food or electrical brain stimulation. While the rats gnawed and licked the lever paired with food, exploratory behavior was directed towards the lever paired with brain stimulation. In many cases this latter behavior included components of the responses that occurred when brain stimulation itself was delivered. In another example of the form of the auto-shaped response matching the response elicited by the reinforcer, a light paired with access to a female pigeon elicited, in male pigeons, courtship behavior directed towards the light (Rackham, 1971).

The Relationship Between Operant and Respondent Behavior

The autoshaping experiments cast considerable doubt on the operant-respondent dichotomy as it has been traditionally defined, for they demonstrate that there are some skeletal responses which can be reliably elicited by a response-independent procedure. However, there are differences which do seem to be reliable, the strongest of these being the results of the presentation of a reinforcer contingent on the nonoccurrence of a specified behavior (a negative response-reinforcer contingency). Zeiler (1976) reports that when a reinforcer is made contingent on the nonoccurrence of a high probability operant response, the frequency of that response decreases. Alternatively, experiments have shown that when the respondent conditioning procedure is modified so that conditioned responses to the stimulus result in the omission of reinforcer presentations (i.e., a negative response-reinforcer contingency is added), the conditioned response continues to occur (Sheffield, 1965; Patten & Rudy, 1967). Patten and Rudy (1967) demonstrated that a conditioned licking response in rats could be both acquired and maintained when water was used as a reinforcer, despite the fact that conditioned responses were never followed by water presentations. Only an average of three out of a possible 25 water presentations occurred during the last days of conditioning. When this negative response-reinforcer contingency was applied to an autoshaping situation, Williams and Williams (1969) obtained results similar to those of Sheffield and Patten and Rudy. Using food as a reinforcer, they found that key-pecking was acquired and maintained in one pigeon at a level at which only five to 20 food presentations per day occurred out of a possible 50. In general, their birds responded on at least 10 percent of the trials once pecking commenced. Thus, there appear to be distinctions between operant and respondent conditioning which may be isolated.

Schwartz and Williams (1972) have demonstrated that although pigeons will continue pecking a key even if pecking prevents grain presentation, they are sensitive to the negative response-reinforcer contingency. When comparing the pecking response to a response-independent key and to a negative contingency key, randomly presented with an inter-trial interval mean of 30 sec, it was found that while pecks were made to both keys, more pecks were made to the response-independent key, and that key was preferred when both were presented together. They concluded that the autoshaped response was at least somewhat sensitive to the response-reinforcer contingency.

Theories of Autoshaping

Skinner (1971) has described autoshaping as "the classical conditioning of a stimulus which elicits a response of phylogenetic origin" (p. 752). He went on to state that the effect is quite different from operant conditioning, even though both procedures generate responses which have similar topographies.

In the autoshaping literature, two theories have been proposed. The earliest, discussed by Jenkins and Moore (1973) is that of stimulus substitution. Taking an object substitution approach to respondent conditioning, the autoshaped response can be explained as the stimulus coming to serve as a surrogate for the reinforcer, which implies that the keylight will be approached and pecked as though it was the grain. Jenkins and Moore (1973) illustrated this clearly by demonstrating the differing forms of the autoshaped response when food or water was used as a reinforcer. The pigeons responded to the keylight as they would to the reinforcer itself.

An alternative proposal has recently been made. Williams' "learned release" theory (see Woodruff & Williams, 1976) states that biologically pre-organized (species-specific) appetitive behavior patterns (e.g. pecking at grain, or bowing and rooting for water in pigeons) are released by stimuli which have preceded a reinforcer. This theory takes into account Jenkins and Moore's (1973) results, as well as those in which the autoshaped response is of a more complete form than the response elicited by the reinforcer. Wasserman (1973), using a heat-light reinforcer with young chicks, found that the autoshaped response of approach, pecking, and snuggling was exhibited towards the key, even though the heat elicited generally unenergetic and undirected postures and movements. Hogan (cited in Hearst & Jenkins, 1974) has noted that approach, pecking, and snuggling towards the hen are normal heat-seeking behaviors of young chicks. Thus, it appears that the key elicited a more complete form of the pre-organized behavior pattern than did the heat itself. In their experiment, Woodruff and Williams (1976) arranged a situation in which water was introduced directly into a pigeon's beak. Therefore, responses to the water were limited to mumbling and swallowing; approach and contact were bypassed. However, the autoshaped response was of a more complete nature, including approach, bowing, and rooting.

Present Study

The purpose of this experiment was to examine the generality of the autoshaped response. Specifically, it was designed to determine if autoshaping is restricted to responses which are biologically pre-organized, as Woodruff and Williams (1976) and Skinner (1971) suggest, or if a response which is not over-learned or pre-organized, but is elicited by an appetitive stimulus (grain), can be autoshaped, as the stimulus substitution theory would predict.

Pomeroy (1962) has stated that birds with abnormal bills may develop eating behaviors appropriate to the beaks which they possess. In the present study, pigeons' upper beaks were removed, so that modified eating behaviors would occur. The autoshaped response to grain as a reinforcer was then examined.

CHAPTER II

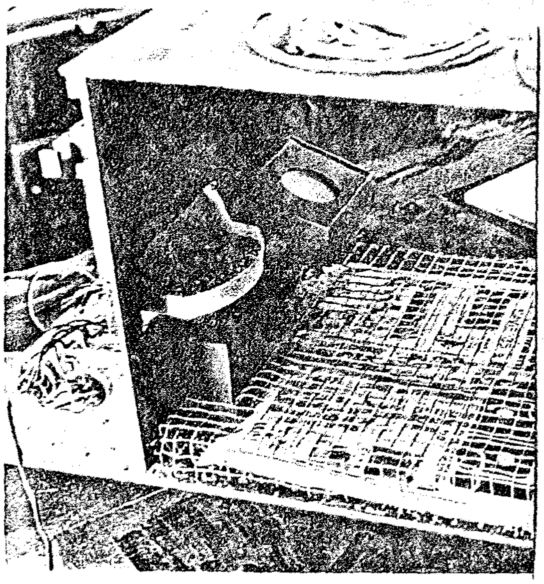
METHOD

Subjects

The experiment began with seven homing pigeons (*Columba livia*), ages three to six months, without previous experimental histories. They were individually housed, and maintained at 70 percent of their free-feeding body weights by restriction of daily food rations during auto-shaping. Food was limited to racer mix with the corn cracked, and was placed in a modified Lustar L-407 tray 12.7 by 7.62 by 1.90 cm located 7.62 cm above the floor of the cage. Canadian field peas were eliminated from the mix since some of the pigeons with modified beaks were able to consume large seeds by normal pecking behavior. Water and grit were continuously available in the home cage.

Apparatus

The apparatus consisted of a specially constructed single-key pigeon chamber (35.56 by 35.56 by 30.48 cm), with a 2.54-cm wire mesh floor (see Figure 1). The response key was a translucent plastic disk (5.08-cm diameter), transilluminated with white light to provide the stimulus. It projected into the chamber at a 20-degree angle from the horizontal, and was located on a box (12.7 by 7.62 by 5.08 cm) which was centered on the right half of the panel 5.08 cm above the floor of the chamber. A 0.32-cm ledge



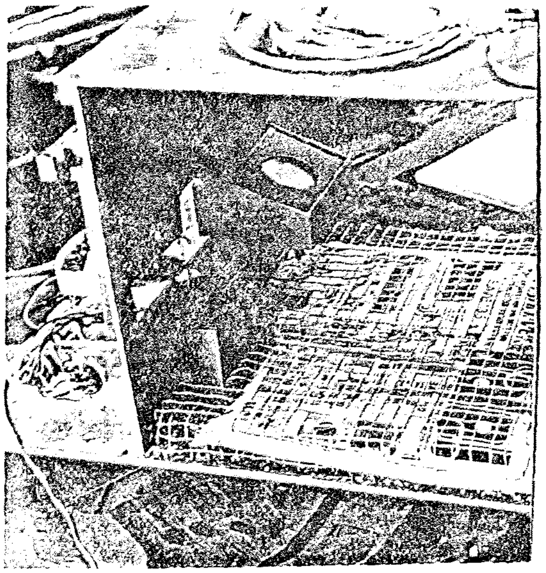


Figure 1. Photographs of the pigeon chamber used in the experiment. The top picture shows the chamber with the food tray rotated to the out position while the lower picture shows the food tray rotated into the chamber.

surrounded the top of the box. A key mounted in this way allowed the opportunity for the pigeon to contact the key with a head orientation identical to that used when contacting grain.

The chamber was constantly illuminated by a diffuse white celing light. The wall next to the key side of the panel was clear plexiglass to provide visual access for a camera and an observer. The remaining walls and ceiling were covered with flat gray paint to minimize reflections from the lighted key. Contingencies were controlled by electromechanical devices. Key closures during keylight presentations were recorded on electromechanical counters, and frequencies were transcribed at the end of each trial. A continuously present masking noise, produced by an AM radio tuned to static, was used to mask extraneous sounds.

The reinforcer was 15-sec access to grain in a retractable, modified Lustar L-407 tray (12.7 by 7.62 by 1.90 cm) centered on the left half of the panel 7.62 cm above the floor of the chamber. A 15.24- by 0.64-cm steel rod was vertically held by two screws to the center of the back of the tray, with 2.54 cm of the rod projecting below the bottom of the tray. The top and bottom of the rod were attached to the back of the panel with plexiglass mounts. A ball bearing in each mount allowed the rod to rotate freely. Below the bottom of the tray the rod passed through a 5.08-cm diameter gear, which meshed with a 1.27-cm diameter gear mounted on a 20 RPM Sessions Clock motor. The motor rotated the tray through a 17.78- by 8.26-cm opening in the panel. The top and sides of the opening were framed by 1.90 cm of 1.27-cm foam rubber, which was flush with the top and sides of the tray. The motor required 6 sec to rotate the tray to a fully extended position, and 6 sec to return it to a fully withdrawn position. The rotating tray was stopped when it was fully extended or withdrawn by a microswitch located under the left side of the tray, behind the panel. The extended tray allowed clear observation of the pigeon's eating response, and permitted consumption of grain by the debeaked pigeons, which would have been limited by a traditional hopper. The foam rubber prevented damage which might occur if a pigeon's head became caught between the rotating tray and the panel.

Procedure

The seven pigeons were first assigned to one of two groups. Five of the pigeons (P-1, P-2, P-3, P-4, and P-5) were debeaked. This procedure involved removing the portion of the upper beak (premaxilla) rostral to the salt gland. The two remaining pigeons (P-9 and P-10) did not have their upper beak removed.

Debeaking procedure. In preparation for surgery, food and water were removed 24 hr prior to anesthesia. The pigeons were premedicated with 0.25 mg atropine and anesthetized with 35 mg/kg intramuscular pentobarbital sodium with supplemental intramuscular administration of 60 mg of chloral hydrate as needed to maintain anesthetic level. When they no longer responded to beak pressure, the portion of the upper beak (premaxilla) rostral to the salt gland was removed with surgical scissors. The remaining portion of the upper beak was immediately cauterized with the side of a red hot scalpel blade. The pigeons were given water as soon as they regained mobility, and were given food 24 hr later. Initially the tray was filled to maximum depth (1.90 cm) with grain. As each pigeon exhibited more efficient modified eating behaviors (i.e., its body weight was maintained) the depth of the grain was gradually reduced until the pigeon was maintained at 70 percent of its free-feeding weight.

Approximately one month after debeaking, three of the five pigeons (P-1, P-2, and P-3) exhibited clearly modified eating behavior in the home cage. Subject P-4 was unable to obtain food and was sacrificed. Subject P-5 continued to obtain food normally until three months after debeaking, at which time clearly modified eating behavior began. Autoshaping for all subjects did not begin until about four months after debeaking, at which time the modified eating response was well established and apparatus construction was completed.

As a result of observations made during the tray training which debeaked subjects received (see Autoshaping procedures, below), five pigeons were reassigned to one of three groups. Debeaked Subjects P-1 and P-2 obtained food in the chamber with modified eating behavior, and so were placed in the Debeaked/Modified (DM) group. Debeaked Subject P-5 obtained food in the chamber with normal eating behavior, and was placed in the Debeaked/Normal (DN) group. Normal Subjects P-9 and P-10 obtained food in the chamber with normal eating behavior, and were placed in the Normal/Normal (NN) group. Subject P-3 was unable to obtain food in the chamber, and consequently could not be used in the autoshaping procedure.

Autoshaping procedures. The procedure followed for Subject P-9 is described below. Similar procedures were employed for the remaining subjects, and so only differences from the procedure used for Subject P-9 are described for them.

Subject P-9: Subject P-9 was first given 10 min to acclimate to the chamber, followed by 40 trials of keylight alone, on a VT 1-min schedule with a keylight duration of 12 sec. Consequent to the keylight-only condition, the autoshaping procedure was implemented. Based on the rapid approach and contact of pilot subjects to the extended tray, no tray training was given. On a VT 1-min schedule, a 12-sec keylight presentation was followed by the availability of grain for 15 sec. This consisted of a 5-sec period during which the subject was able to obtain grain from the tray as it was rotating to the fully extended position, a 6-sec period during which the tray was stationary, and a 4-sec period during which the tray was rotating to the fully withdrawn position. The keylight remained on until the tray began to withdraw. Each session was terminated at the end of the fiftieth keylight-food pairing. The autoshaping procedure continued until Subject P-9 contacted the key with its beak during 17 keylight presentations. The eating response during nine grain presentations was videotaped, as was the key response during 15 keylight intervals.

The procedure followed for the remaining subjects was identical, with the following exceptions:

Subject P-10: The autoshaping procedure continued until Subject P-10 contacted the key with its beak during 16 keylight presentations. The eating response during ten of the grain presentations was videotaped, as was the key response during 15 keylight intervals.

Subject P-2: The modified eating behavior of Subject P-2 did not allow it access to grain during much of the period when the tray was rotating into and out of the chamber. In order to compensate for this, the time during which the tray remained stationary in the fully extended position was increased to 9 sec, and the 15-sec access to grain was maintained. It consisted of a 3-sec period during which the subject was able to obtain grain from the tray as it was rotating to the fully extended position, a 9-sec period during which the tray was stationary, and a 3-sec period during which the tray was rotating to the fully withdrawn position. Despite this adjustment, Subject P-2 rarely approached and contacted the tray during the first three autoshaping sessions. After tray training, the subject readily ate from the tray, and the autoshaping procedure was repeated. This continued until Subject P-2 contacted the key with its beak during 15 keylight presentations. The eating response during six of the grain presentations was videotaped, as was the key response during 12 keylight intervals.

Subject P-1: One tray training trial was given after the 10-min acclimation period. As with Subject P-2, the tray was stationary in the fully extended position for 9 sec, allowing 15-sec access to grain. The autoshaping procedure continued until the subject contacted the key with its beak during 17 keylight presentations. The eating response during ten grain presentations was videotaped, as was the key response during 15 keylight intervals.

Subject P-5: Four tray training trials followed the 10-min acclimation period. The 15 sec of grain access was maintained with the tray stationary in the fully extended position for only 6 sec. The autoshaping procedure continued until Subject P-5 contacted the key with its beak during 17 keylight presentations. The eating behavior during the first and last five grain presentations was videotaped, as was the key response during 15 keylight intervals.

Rating of responses. Videotapes of the subjects' responses to the tray and the key were rated by the author and a trained observer familiar with both normal and modified pigeon eating behavior. The tape of each tray and keylight presentation was replayed as often as requested by the raters and, modifying Jenkins and Moore's (1973) rating procedure, every interval was scored as having contained either only normal responses, only modified responses, or both types of responses. A response began with a downward movement of the beak while the head was over the tray or the key box, and ended with either a contact with the tray or the key or with an upward movement. The beak was not required to contact a surface. This was because it was difficult to tell from the videotape which responses were actually contacting a surface and which ones stopped short of the surface. A normal response was defined as a response in which the head was at an angle less than 45 degrees from the pigeon's dorsal axis, and the beak tip followed a straight line downward. A modified response was defined as a response in which the head was at a 45-degree angle or greater from the pigeon's dorsal axis, and/or the beak tip followed any part of a clockwise circular path moving downward as viewed from the right side.

This description is typical of the modified eating response.

Reliability for the scoring of both tray and key intervals was calculated for each subject. It was computed by dividing the scored agreements by the agreements plus the disagreements, and multiplying by 100. The dependent measures were the percentages of tray and key intervals scored as containing only normal responses, only modified responses, or both types of responses.

CHAPTER III

RESULTS

Home Cage Eating Behavior

The normal subjects (P-9 and P-10) contacted the tray in the home cage while standing directly in front of the tray, with both head and body perpendicular to the length of the tray. The beak tip followed a straight path down and away from the body, and grain was pinched between the upper and lower beak. This eating response was the only one observed to be exhibited by these two subjects.

In contrast to this, two of the debeaked subjects (P-2 and P-5) contacted the tray in the home cage while positioned with both feet clasped on the ledge of the tray, with the body almost parallel to the length of the tray. The head was turned as much as 90 degrees from the pigeon's dorsal axis, and curled under the body. In this inverted position, the portion of the upper beak which remained scooped up the grain as the beak moved in a rotary motion. The extremeness of the modified eating behavior varied within and between subjects. In general, Subject P-2 exhibited the most extreme modification, and did so in almost all of its responses. The probability for Subject P-5 was the same, though its responses were not as extreme.

The eating behavior of Subject P-1 was also modified, but in a slightly different manner. Like the normal pigeons, it contacted the tray in the home cage while standing directly in front of the tray, with its body perpendicular to the length of the tray. However, the head was turned as much as 90 degrees from the pigeon's dorsal axis, and the portion of the upper beak which remained scooped up the grain as the beak moved in a rotary motion. This modified response was exhibited in approximately three-quarters of the pigeon's eating responses.

The relative efficiency of a pigeon's eating response may be roughly measured by the amount of food which the pigeon must be given in order for it to consume a quantity sufficient to maintain a set weight. Less efficient responses may result in much seed being spilled, while the most efficient response ends with all available food consumed. The relative efficiency of the eating responses exhibited by the debeaked pigeons can be demonstrated by comparing the amount of grain which they required in order to maintain 70 percent of their free-feeding weight, to the amount necessary for the normal subjects. The normal subjects (P-9 and P-10) required 6 and 5 g daily, respectively, while the debeaked pigeons (Subjects P-1, P-2, and P-5) needed 30, 10, and 15 g daily, respectively. Thus, the debeaked subjects required between two and six times more food than the normal pigeons in order to maintain their weight.

Acclimation and Keylight-Alone Behavior

None of the subjects contacted the key during the 10-min acclimation period, and only Subject P-9 contacted the key with its beak in the keylight-alone condition. This occurred during the seventh keylight presentation, and did not recur for the remainder of the condition. Foot-key contact was a high frequency response for Subjects P-2, P-9, and P-10 during the keylight-alone condition, but had an equal probability whether or not the keylight was present. They occurred when the subject occasionally perched or jumped onto the key box.

Chamber Eating Behavior

Figure 2 indicates the percentage of tray intervals containing only normal responses (N), only modified responses (M), and both types of responses (B) for each subject, as scored from the videotapes by the author. In the intervals rated, the NN subjects both exhibited only normal responding. For the DN subject, 90 percent of the scored intervals contained only normal responses. During one interval a single rotary response occurred, and this accounts for the 10 percent of the intervals containing both types of responses.

A high percentage of the intervals rated for the DM subjects contained both modified and normal responses, while a smaller percentage were scored as only modified. The normal responses which occurred were generally confined to

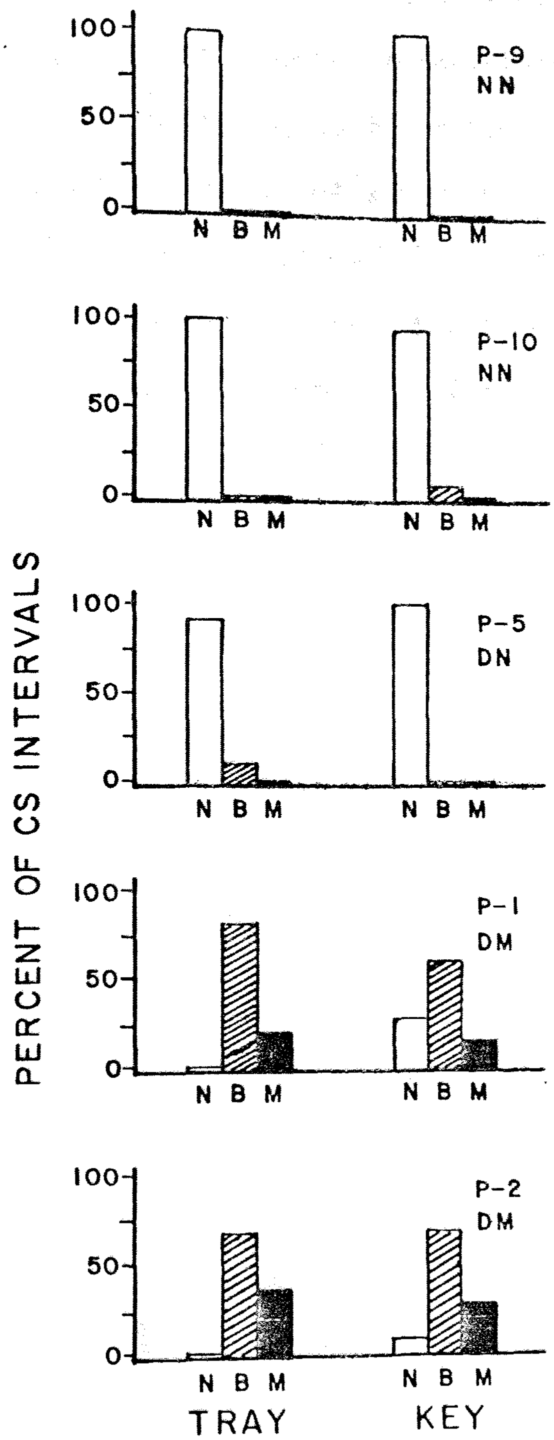


Figure 2. The percentage of tray and key intervals containing only normal responses (N), only modified responses (M), and both types of responses (B) for each subject, as scored from the videotapes by the author.

the period during which the tray was rotating into the chamber. None of the intervals consisted of only normal responses. For Subject P-1, 80 percent of the tray intervals contained both types of responses, and during 20 percent of the intervals only modified responses were exhibited. The corresponding percentages for Subject P-2 were 67 and 33 percent. The modified responses exhibited by Subject P-2 were typically less extreme than those which occurred in the home cage. During only one interval did Subject P-2 stand on the tray while eating.

The relative efficiency of the subjects' eating responses was measured earlier as the amount of food required daily in the home cage. In the chamber it may be roughly measured by comparing the amount of weight gained by each pigeon during a typical session. The NN subjects gained between approximately 30 and 60 g, while Subject P-5 (DN) gained between 10 and 30 g. Subjects P-1 and P-2 (DM) only gained between 0 and 10 g during a session.

Key Contacting Behavior During Autoshaping

Frequent foot-key contacts were exhibited by every pigeon during the autoshaping procedure. As in the keylight-alone condition, foot-key contacts were unrelated to keylight presentations.

All subjects contacted the key with their beaks while the keylight was on, and there were no consistent differences in the number of trials to the first contact, or in the last trial (usually the seventeenth) in which such a contact occurred. The first and last trials for Subjects P-1 and P-2 (DM) were 4 and 172, and 85 and 149, respectively. For Subject P-5 (DN) it was 237 and 272. For Subjects P-9 and P-10 (NN) they were trials 3 and 66, and 225 and 251, respectively. Response frequencies are not available, because both foot and beak contacts were recorded on the electromechanical counter.

Figure 2 indicates the percentage of key intervals containing only normal responses (N), only modified responses (M), and both types of responses (B) for each subject, as scored from the videotapes by the author. In the intervals rated, the NN subjects exhibited normal responding almost exclusively (100 and 93 percent). During one interval Subject P-10 made a slight rotary response, and this accounts for the seven percent of the intervals containing both types of responses. The DN subject exhibited only normal responding.

The majority of the intervals scored for the DM subjects consisted of both normal and modified responses, while smaller percentages of intervals contained only normal responses and only modified responses. For Subject P-1, 60 percent of the key intervals contained both types of responses, 27 percent contained only normal responses, and 13 percent contained only modified responses. The respective percentages for Subject P-2 were 67, 8, and 25.

The modified responses which occurred were much less extreme than those directed to the tray, consisting almost exclusively of a rotary movement of the beak in its downward path. Subject P-1 occasionally turned its head at a slight angle from the dorsal axis, but not to an extent sufficient for the response to be rated as modified. Subject P-2 contacted the key with its head and body perpendicular to the panel.

Reliability

Reliability was generally high (see Table 1). For the NN and DN subjects, agreement ranged from 93 to 100 percent. The percent agreement was slightly lower for the DM subjects. For Subject P-1 agreement for both tray and key intervals was 80 percent, and for Subject P-2 agreement was 83 percent for tray intervals and 58 percent for key intervals. The 58 percent agreement figure mainly resulted from four intervals in which one rater scored both normal and modified responses as having occurred, and the other rater scored only modified responses. However, the difference in scoring was not systematic across raters.

Table 1

Reliability Table

(Agreements/Agreements + Disagreements x 100)

Group	Subject	Tray	Key
NN	P-9	100%	100%
	P-10	100%	93%
DN	P-5	100%	93%
DM	P-1	80%	80%
	P-2	83%	58%

CHAPTER IV

DISCUSSION

The results of this study demonstrate that a pigeon's normal eating behavior can be modified by debeaking, and that a component of this modified response is directed to a keylight which is paired with grain availability. The normal responding of the NN subjects shows that the type of tray and key used had no effect on the form of the response typically observed in pigeons. The keylight responses exhibited by the DN subject indicate that modified responses directed to the key were controlled by the response to grain paired with the keylight, rather than simply having been debeaked or having contacted grain with modified behavior in another environment (i.e., the home cage).

The percentages of tray and keylight intervals in which only normal responses, only modified responses, and both types of responses occurred were markedly similar within subjects and within groups. However, for the DM subjects only one component of the modified response to food was directed to the key. Thus, the modified keylight responses actually contained components of both normal and modified eating behavior: The head was at an angle less than 45 degrees from the dorsal axis, but the beak tip moved downward following a circular path. Such results are not predicted, nor can they be solely explained, by a theory of biological pre-organization (Skinner, 1971; Woodruff & Williams, 1976) or one of stimulus substitution (Jenkins & Moore, 1973). The former theory would predict that the DM subjects would contact the key with only normal responses, despite the clearly modified behavior directed to the food, since a normal response is the biologically pre-organized one. The 3- to 6-month history of normal responding which all subjects had prior to this study demonstrates that this biological pre-organization existed, and it could not have been affected by debeaking. Despite this, the DM subjects both exhibited a high frequency of keylight responses which were clearly not normal. Contrary to what the stimulus substitution theory would predict, however, these pigeons did not respond to the keylight as they did to the grain. Subject P-2 never contacted the keylight while standing on the key box, and neither subject ever exhibited a keylight response which included both components of the modified eating behavior.

The type of key employed in this study allowed comparison of head orientations exhibited to the key and the tray, and the food-delivery device permitted the opportunity for modified eating responses to occur and for all eating behavior to be clearly observed. However, there were problems with the key and tray design. The subjects often perched or jumped on the key box, and the foot-key contacts which resulted had to be isolated from beak-key contacts. The rotation of the tray may have limited the extremeness of Subject P-2's eating response, since standing on the tray was always consequated by being rotated into the panel as the tray withdrew from the chamber. In addition, though 15-sec grain access was consistent across all subjects, there were marked differences in amount of grain actually consumed (as measured in weight gained per session) by each group. Despite these weight-gain differences, however, there were no consistent between-group differences in the rate of acquisition (as measured in the number of trials to the first beak-key contact) or the strength of conditioning (as measured in the number of trials from the first to the last beak-key contact).

The major procedural problem involved the videotaping of responses. Due to the variety of body and head orientations which the pigeons exhibited while contacting the tray and the key, no single camera position could allow clear taping of all the responses. During some intervals, Subject P-1 contacted the tray with its head turned at such a severe angle that only the back of its neck could be taped. Subject P-2 occasionally stood on the tray while eating, with its back facing the camera. All subjects often turned their heads at angles not relative to the dorsal axis, and sometimes at angles relative to more than one axis simultaneously. This problem prevented a finer analysis of the responses which were exhibited.

This study suggests that a response which is not overlearned or pre-organized, but is elicited by an appetitive stimulus (grain) can to some extent be conditioned by an autoshaping procedure. Further experimentation in this area is necessary before all the variables which control the form of the autoshaped response can be determined. These variables must account for the results of this study as well as those of Woodruff and Williams (1976) and Wasserman (1973). Debeaking may be a particularly useful procedure in such experiments, since it results in a learned eating response which may be directly compared to the biologically pre-organized eating behavior of normal subjects.

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